APPLICATION FOR UNITED STATES LETTERS PATENT

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TITLE: IMAGE ENCODING METHOD AND IMAGE ENCODER

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SPECIFICATION

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the priority of German Patent Application No. 100 41 037.5 filed

August 22, 2000, the subject matter of which is incorporated herein by reference.

Image encoding method and image encoder

Description

5   The invention relates to an image encoding method as per the
preamble of claim 1, and to an image encoder for realizing
said method.

Digital image processing, nowadays, as a rule, in short called
10   image processing, is a rapidly developing technical field with
manifold and increasingly expanding application possibilities.
The spectrum of use extends from destruction-free material and
construction tests over automatic control of robots and entire
industrial plants, over astronomy, high-energy physics,
15   cartography and meteorology, up to the most diverse biological
and medical applications.

Digitization of an image or image encoding may ensue in
various ways - photographs or drawings present on a carrier
20   are scanned line-wise, whereas images present as an (analog)
video signal may be transformed directly into data bit
sequences by analog-to-digital conversion on the electronic
way. Basically, digitization comprises two steps, namely of
dividing the image model into small partial areas called
25   pixels (screening), and of allocating a luminance or
chrominance value to each pixel (quantization).

On the part of the users, higher demands are permanently made
with respect to spatial resolution, i.e. the number of pixels
30   per surface unit, and the number of quantization stages of the
luminance or chrominance values, for one, and with respect to
the amount of image material to be processed and the
processing speed, for another. Hence, it is the question of an
as fast as possible processing of very large image data

amounts, so that for a prolonged period of time, intensive developments as to the possibilities of data compression or even data reduction have been conducted. A plentitude of methods is already in practical use in the different fields of

5   application, whereby bit map-oriented methods have to be distinguished from the image encoding as a wave function or of the vector encoding.

The objective of all of these methods is to describe the image

10 to be encoded by as few as possible data to be stored or to be transmitted. For reducing the image data volume, it is also known not to store or transmit less important image details, to combine image data of pixels lying close to each other, to shorten image-describing wave functions by wave portions

15 having minor information content, etc.. The objective of these methods for image data compression is to save storage space requirement or to accelerate image data transmission, respectively.

20 Starting point of the essential known methods for image description is a so-called bit map, which is obtained for each pixel by dividing the image into a XY matrix of pixels, and by allocation of a storage area, where a luminance value and, if necessary, a chrominance value are memorized as digital

25 values. Hereby, the pixel is allocated that luminance or chrominance value from a predetermined sequence of discrete luminance or chrominance values, which coincides most with the actual chrominance value.

30 With this procedure applies: An image is a fixed number of pixels, each having allocated a luminance value and/or chrominance value. The number of the used pixels, for one, and the number of the used luminance and chrominance gradations, for another, differ very considerably in dependence of the

specific application. Independent of the actual determination of the corresponding values, these methods experience principal limitations with respect to the compressibility or reducibility of the image data volume.

5

The invention therefore is based on the objective task of providing an image encoding method having essentially improved image data compression possibilities or image data reduction possibilities, respectively. Moreover, a corresponding

10 powerful and fast image encoder is intended to be proposed.

This objective task is solved with respect to the process aspect by an image encoding method having the features of claim 1, and with respect to its device aspect by an encoder

15 having the features of claim 10.

The inventive method, which can in short be designated DLC method (DLC: Dynamic Luminance and Chrominance Encoding/Decoding), includes the following fundamental

20 processing rule: An image is a fixed – yet independent of the image content – number of chrominance and luminance values, which are allocated the pixels obtained by screening.

For encoding an image according to this method, it is started

25 – departing from introduced techniques – in particular from a bit map file of already digitized image data. During the realization of the method, it is first analyzed, which luminance and chrominance values are present at all in the image. Non-occurring luminance and chrominance values are

30 eliminated from the processing-relevant luminance and chrominance scale, since these are not required for the image description. Alone hereby already, it is possible to considerably reduce the volume of the data bit sequence or "DLC file" (in dependence on the image content) forming the

method result, without an information loss occurring. The
chrominance or luminance values required for the image
description are subsequently allocated the pixel coordinates
or pixel numbers defining those pixels, in which the
5   respective chrominance or luminance value is present.

In the most common realization of conventional image
processing methods, the pixels are allocated pixel coordinates
as value pairs of Cartesian coordinates (X and Y parameters).
10   The pixels accordingly are indicated in the data bit sequence
generated according to this method as value pairs, whereas the
luminance or chrominance values, to which the pixels are
allocated, are preferably encoded as single numerical values.
In another realization - which in practice surely is less
15   important - the pixels are allocated polar coordinates (r and
φ values) - and here, as well, the luminance and chrominance
values are preferably encoded as single numerical values.

In a preferred manner, the pixels allocated to the arising
20   luminance and chrominance values are encoded in the data bit
sequence in a predetermined order of the luminance and
chrominance values, whereby in one suitable realization, all
pixels allocated to a determined luminance or chrominance
value, are in each case preceded by a value characterizing the
25   distance to the preceding luminance and chrominance value.
This proceeding furnishes special advantages with images,
which are particularly "gappy" with respect to the luminance
and chrominance scale. In place of the mentioned distance
values, however, the absolute luminance or chrominance values
30   may as well be encoded in the data bit sequence, said absolute
values being in each case followed by the associated pixel
numbers or pixel coordinates.

As a simplified example herefor, the image data encoding for
an image having 649 x 480 pixels and 128 chrominance values
will be sketched in the following. It is to be understood that
for a larger number of pixels and a more finely gradated
colour range, as well as for the (additional or sole) encoding
of luminance values, the analog proceeding can be carried out.

The following allocation of selected chrominance values and
pixels would apply to the image:

Chrominance value	pixels	(X/Y)			
1	88/78	78/88	78/89		
2					
3					
4					
5	55/55				
...					
22	27/56	27/57	66/89		
23	17/88	18/78			
128	67/78	67/90	123/89	126/67	200/56

As a first step of data compression, storage or transmission
of chrominance values which have no pixels allocated, are
renounced of. Therewith, the DLC file presents itself as
follows:

1	88/78	78/88	78/89		
5	55/55				
...					
22	27/56	27/57	66/89		
23	17/88	18/78			
128	67/78	67/90	123/89	126/67	200/56

Next, according to an algorithm implemented in the image encoder, as well as in the image decoder, a sequence of numbers is generated, in which the numbers separated from each other by a slash designate the X and Y coordinate of a pixel,

5   whereas single numbers designate a distance to preceding chrominance values ("leap in the chrominance value"). The following sequence of numbers arises: 88/78   78/88   78/89
4   55/55   17   27/56   27/57   66/89   1   17/88   17/78
105   67/78   67/90   123/89   126/67   200/56.

10

An additional possibility for data compression ensues, when within one image, a determined number of partial images is defined according to a predetermined algorithm, e.g. two partial images (left/right) or four partial images (left

15   top/right top/left bottom/right bottom), and when in the image encoder and decoder software the declaration is implemented that within the sequence of numbers (data bit sequence), the description of the next partial image will start, when after ascending X and Y coordinates lower values arise again.

20

This as well shall be explained by means of an example:

↓ here start coordinates
of a new partial image

25   12/45   34/78   67/89   123/124   28/67   67/89

↓ skip   ↓ here start
partial image   coordinates
of a new

30   partial image
12/45   34/78   0/0   67/89   123/234   156/245   28/67   67/87

An essential possibility for data reduction ensues by the fact that luminance values and/or chrominance values, which have a

number of pixels allocated falling below a determined
threshold value, are not encoded in the DLC file. In the
simplest case, the corresponding pixels no longer appear at
all in the reduced data bit sequence. This proceeding is

5   refined by the fact that those pixels, the luminance and/or
chrominance values of which are not encoded, are in each case
allocated to the next adjacent luminance and/or chrominance
value. The first mentioned possibility, which is simpler as
far as encoding is concerned, may be refined in that those

10 pixels on the decoder side, for which no luminance or
chrominance value was furnished, are allocated a value
calculated from information on the surrounding pixels.

Hereby, for restricting the consequences of information loss,

15 it is possible to define protected image areas. If a pixel
originates from this specifically defined area, implemented
data reduction procedures are not at all applied herefor or
only pursuant to a moderated mode. The relevant information
has only to be present in the image encoder and has not to be

20 communicated to the decoder, so that this procedure does not
require additional transmission capacity.

The above-mentioned process steps and aspects comprise in each
case in the realization of an image encoder an equivalent in

25 device in the hardware and software configuration. The
inventive image encoder comprises in particular a pixel
allocation means for realizing the mentioned allocation of
numbers or coordinates of pixels to the separately arising
luminance or chrominance values. Moreover, it comprises in

30 particular a luminance value/chrominance value detection means
for examining the image – or a primary bit map – for
occurrence of the individual luminance value and/or
chrominance value from a predetermined plurality of such
values.

Finally, the image encoder in particular comprises a digital
input for a primary data bit sequence (bit map), and a digital
output for the secondary - compressed and, if necessary,

5   reduced - data bit sequence (DLC file).

In a realization enabling the above-mentioned data reduction
by non-encoding rarely occurring luminance or chrominance
values, the image encoder comprises a luminance threshold

10   value discriminator/chrominance threshold value discriminator,
and a counter means connected to the latter and the luminance
detection means/chrominance detection means for ascertaining
the number of pixels allocated by a determined luminance value
or chrominance value, and for discriminating said number of

15   pixels at a predetermined (programmed) threshold value.

To these components, an adjacent value allocation means is
connected in a further specific realization, which allocates
the next adjacent luminance value or chrominance value of the

20   primary value scale to those pixels, the original luminance or
chrominance value of which are not encoded due to the small
number of allocated pixels.

In a further specific realization, the image encoder comprises

25   an image dividing means becoming effective in the initially
mentioned step of screening the image, and which either
defines an image area with high priority (or even several of
such image areas) and/or subdivides the image into partial
images with in each case separate pixel numbering or pixel

30   coordinate allocation.

The realization of the invention is not restricted to these
aspects and the above-mentioned simplified examples, rather it
can be realized within the framework of the enclosed claims in

a multitude of modifications being within the scope of the skilled person's proceeding.

Also, the use of numerous methods already known for data

5 reduction and data compression is reasonably possible by means of the DLC method for the purposes of an utmost large reduction of the data amount. Thus, for example, the known method of run-length coding represents one possibility of further reducing the number of bits to be stored or

10 transmitted. Well suited for combination with the DLC method is the method of forming image clusters, in which the transmission of adjacent pixels having equal luminance or chrominance information ensues by formation of a cluster, which can be described in an abbreviated manner as a

15 condensation of these pixels.